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Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

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Item 5 (c) of the provisional agenda
Transportation of gases:
Low flammability and non-flammable refrigerant gases

Flammable gases in non-refillable pressure receptacles

Transmitted by the Council on the Safe Transportation of Hazardous Articles (COSTHA)*

I. Background

1. The heating, ventilation, air conditioning and refrigeration (HVAC&R), automotive motor vehicle air conditioning (MVAC) or mobile air conditioning (MAC) systems, and other fluorocarbon using industries are currently going through a series of transitions. First, Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) were invented in the 1920s. With its non-flammable and low toxic characteristics it became a popular use as refrigerants for HVAC&R, MVAC/MAC, aerosols, foams, solvents, and other applications. However in 1974, Frank Sherwood Rowland and Mario J. Molina suggested that these substances can deplete the ozone layer and this led to the creation of the Montreal Protocol to phase out these so-called ozone depleting substances (ODS) in 1987 and the Montreal Protocol was ratified by 198 parties, making it the first universally ratified treaty in the United Nations (UN) history.

2. As these ODS were being phased down and out, alternative refrigerants like Hydrofluorocarbons (HFCs) became common. In fact, due to this, the Government of the United States of America submitted a proposal to the Sub-Committee as noted in report ST/SG/AC.10/C.3/30 on 22 July 1998 for a creation of UN 3358: Refrigerating machines, containing flammable, non-toxic gases, with a special provision 291, which allowed these machines to be transported with flammable gas with less than 12 kg charge except for air shipments.

3. HFCs, unlike ODS, do not harm the ozone layer. However, these non-ODS HFC gases have a relatively high global warming potential (GWP), which can be 1,000 to 10,000 times more than CO_2. This raised a big concern that led to the creation of the Kigali Amendment of the Montreal Protocol in 2016, which began a production freeze in 2019 and a gradual phase down of HFCs based on their GWP values up to 80 to 85 per cent reduction from baseline. Advanced countries, also known as non-A5 countries, will phase down 85 per cent

* A/79/6 (Sect. 20), Table 20.6.

by 2036, and emerging countries known as A5 countries will phase down 80 per cent by 2045 or 85 per cent by 2047. As of 1 July 2024, 160 states and the European Union ratified the Amendment.

4. As these high GWP HFC refrigerants are being phased down, alternative refrigerants such as lower GWP HFC, hydrofluoroolefins (HFOs), HFC/HFO blends, and hydrocarbons are being used. For example, in the United States, currently used refrigerant R410A (a blend of HFC-32 and HFC-125) has a GWP of 2088, but is being transitioned to HFC-32 (GWP of 675) and R454B (GWP of 466) for residential HVAC systems. The trade-off from high ODS/GWP to low or no GWP refrigerants is flammability and toxicity. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) which classifies flammability and toxicity has created a new flammability class 2L which is categorized under lower flammability also often referred to as "mildly flammable" with a burning velocity of 10 cm/sec or less. UN *Globally Harmonized System of Classification and Labelling of Chemicals* (GHS) has also created a similar classification Category 1B flammable gas to distinguish between highly flammable and mildly flammable gases.

5. HVAC&R and MVAC/MAC has been essential to lives by reducing health issues and refrigeration for preserving food. This need will continue to rise, and according to International Energy Association (IEA) in "The Future of Cooling report" issued in 2018 predicts the use of air conditioners to triple by 2050. In addition, the acceleration of use of heat pump systems is rapidly growing, this all leads to the use of lower or no GWP refrigerant gases which are flammable. In 2022, the UN Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC) report also mentions that it is expected that the phasedown according to the Kigali Amendment will rapidly advance the use of low- and ultra-low GWP alternatives.

6. HVAC systems are mostly pre-charged with refrigerants at production facilities. However, additional refrigerants need to be charged on-site depending on the application to adjust the required volume-based refrigerant piping that connects between an evaporator and condensing unit. Refrigerant is also used during repairs or to top off leaked amounts. In the refrigeration sector, refrigerants are commonly charged on site as the system is being built. These refrigerants have been commonly used in non-refillable pressure receptacles in either 11.3 kg or 13.6 kg filling for non-flammable refrigerants.

7. With the industry's transition from high GWP refrigerants to low or no GWP refrigerants, there needs to be adequate supply chain of alternative refrigerants that is flammable.

II. Issue

8. *Model Regulations*, paragraph 4.1.6.1.9 (b) states:

> "Non-refillable pressure receptacles shall:
>
> Be of a water capacity less than or equal to 1.25 litres when filled with flammable or toxic gas; "

9. This requirement limits refrigerant cylinders to a charge size of 1 kg, and therefore HVAC&R contractors and auto technicians would have to use many cylinders to fill up a system. The other option is to use refillable pressure receptacles, but this is not common in areas such as Latin/South America, Southeast Asia, and the Global South as there are limited or no refrigerant distributors that can repackage from bulk into refillable pressure cylinders. While hydrocarbons such as propane used for fuel source has distribution channels globally, refrigerants are much smaller distribution volumes and are high purity gases which can also be blends. Quality control in repackaging is essential at the same time being sophisticated as lower quality or off spec composition of a refrigerant can lead to poor performance or system failure of HVAC&R and MVAC/MAC systems.

III. Proposals

10. To address this issue, it is proposed to take the following actions:

(i) Introduce a new entry UNXXXX, REFRIGERANT GAS, FLAMMABLE, N.O.S.

(ii) Create a new special provision XYZ to state:

XYZ Non-refillable pressure receptacles shall be water capacity less than or equal to 25 litre (25 kg) for a service pressure of 34.5 bar (500 p.s.i.g.) or less with flammable gases which are not pyrophoric, nor unstable, and which have at least either (a) a lower flammability limit of more than 6% by volume in air; or (b) a fundamental burning velocity of less than 10 cm/s, with pressure relief device that is governed by the national authority of the country of use such as Compressed Gas Association (CGA) Publication S-1.1

(iii) Apply special provision XYZ to the following entries:

(a) UN XXXX REFRIGERANT GAS, FLAMMABLE, N.O.S.

(b) UN 3161 LIQUEFIED GAS, FLAMMABLE, N.O.S.

(c) UN 3252 DIFLUOROMETHANE

IV. Justification

11. There are two reasons why it can be considered that 1.25 litre limitation can be increased:

Internationally, there are various regulations that allows charge size above 1.25 litres:

(A) In the United States of America, US DOT regulations states the following:

49 CFR § 178.65 Specification 39 non-reusable cylinder

(a)(1) Size limitation.

Maximum water capacity may not exceed: (i) 55 pounds (1,526 cubic inches) for a service pressure of 500 p.s.i.g. or less, and (ii) 10 pounds (277 cubic inches) for a service pressure in excess of 500 p.s.i.g.

There have been millions of 4.5 kg or 11.3 kg of Class 2.1 R1234yf: UN3161 Liquefied Gas, Flammable, N.O.S. (2,3,3,3-TETRAFLUOROPROP-1-ENE) in specification DOT-39 non-refillable pressure receptacles being circulated within the United States since 2012.

(B) In Japan, Class 2.1 R32: UN3252 Difluoromethane and R1234yf: UN3161 Liquefied Gas, Flammable, N.O.S. (2,3,3,3-TETRAFLUOROPROP-1-ENE) is classified as particular inert gas under High Pressure Gas Safety Act, and is considered as 2.2 non-flammable, and these gases have been circulated within Japan also since 2012.

(C) In China, Class 2.1 R32: UN 3252 Difluoromethane and R1234yf: UN 3161 Liquefied Gas, Flammable, N.O.S. (2,3,3,3-TETRAFLUOROPROP-1-ENE) is allowed to be charged up to 10 kg under their national standards GB/T 17268-2020 and TSG 23-2021 and have been in circulation.

(D) Since 2012, there has been more than 280 million units of UN 3358: Refrigerating machines, containing flammable, non-toxic, liquefied gas being circulated in over 130 countries (as of December 2023). Under special provision 291, these machines are allowed to be transported with flammable gas with less than 12 kg charge except for air shipment. Based on its minimum ignition energy, UN 1978 Propane is 260 times higher than UN 3252 Difluoromethane, which would mean that 12 kg of pre-charged propane would be equivalent to 3,120 kg of difluoromethane in a refrigerating machine.

12. In the cases of 11 (A), (B), (C), and (D), more than a decade has passed and we are not aware of any accidents reported.

13. Furthermore, one global refrigerant producer, has been distributing R1234yf in US DOT-39 cylinders (mostly in 4.5kg and 11.3kg net amounts) from 2013 and to date, they were able to reduce over 1kMT of steel, 0.07k MT of cardboard, and 3k TEU (Twenty-Foot Equivalent Unit) worth of shipment from distributing in non-refillable cylinders above 1.25L in the United States of America. Based on our calculations, on a global scale, it would reduce approximately 62kMT of steel, over 3kMT of cardboard use, and 184k TEUs annually (Global excluding countries and areas like Australia, Canada, European Union and India where non-refillable cylinders regardless of its flammability are not allowed and China, Japan and United States of America where non-refillable cylinders above 1.25L are allowed.)

14. In summary, HVAC&R and MVAC/MAC systems will expand in the coming years and that means more refrigerants, especially low or no GWP refrigerants that are mildly flammable, will also have an increasing demand. As detailed in paragraph 11 **(A), (B), and (C), non-refillable cylinders that have a higher charge volume than 1.25 litre have been in circulations in millions for over a decade and we are not aware of any incident being reported; they have a proven safety track record.** Therefore, increasing the limit of non-refillable pressure receptacles' water capacity from 1.25 litre to 25 litre (25 kg) for a service pressure of 34.5 bar (500 p.s.i.g.) or less with these flammable gas not pyrophoric, nor unstable, and which have at least either (a) a lower flammability limit of more than 6 per cent by volume in air; or (b) a fundamental burning velocity of less than 10 cm/s and fitted with a pressure relief device that is governed by the national authority of the country of use such as Compressed Gas Association (CGA) Publication S-1.1 is unlikely to cause additional safety hazard.